

Biology

Name: _____ Bl: ____

Understanding Cladistics

(from the American Museum of Natural History, “Cladistics”)

Essential to our understanding of the world and our place in it is the understanding that all living things have evolved as a result of inherited changes and diversification over vast periods of time. The fossil halls exhibit animals, both living and extinct, that represent the evolutionary history of vertebrates. As people trace their family history by compiling a family tree, so scientists can also reconstruct evolutionary history by compiling evolutionary “family trees.” Therefore, the Museum of Natural History, where evolution is a major area of research, decided to organize these halls as an evolutionary tree of vertebrates.

What is the best way to reconstruct evolutionary history?

Scientists build evolutionary trees using a method called *cladistics*, in which organisms are grouped according to shared features. The distribution of features forms a set of nested groups, in which smaller groups are contained within larger ones. For example, the group “tetrapods” (animals with 4 limbs) is contained within the larger group “vertebrates” because tetrapods, like other vertebrates, have a backbone and a braincase, which are the defining features of the group called vertebrates. Each group, or *clade*, is recognized by a set of such advanced features inherited from a common ancestor. A clade contains all descendants of the common ancestor.

What is a cladogram?

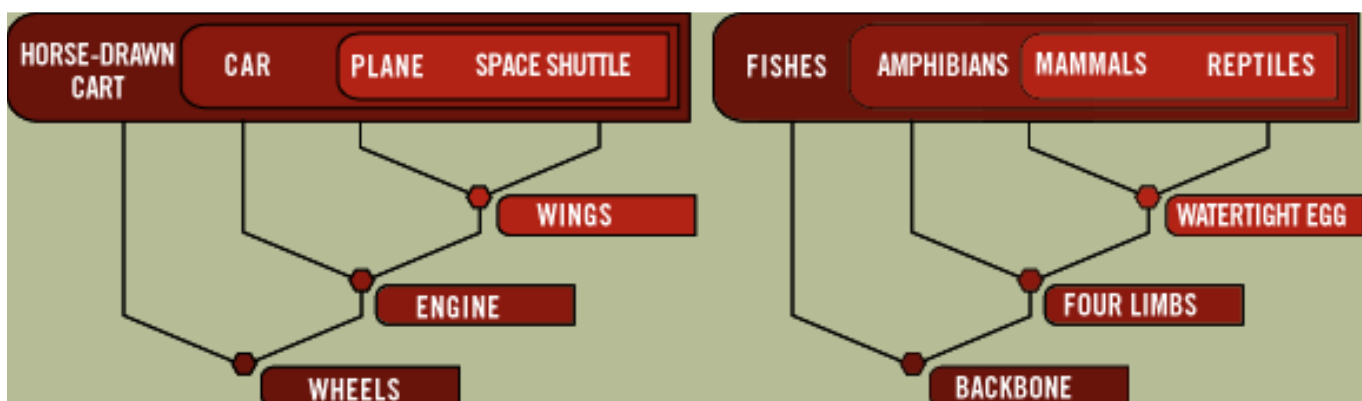
A cladogram is visual reconstruction of the evolutionary history of a group of animals, based on the distribution of newly evolved (“advanced”) features. Cladograms are drawn as branching diagrams, with the advanced features noted at the appropriate branching points. Compare the cladograms below, one of which shows the “evolution” of advanced modes of transportation, the other the evolution of vertebrates.

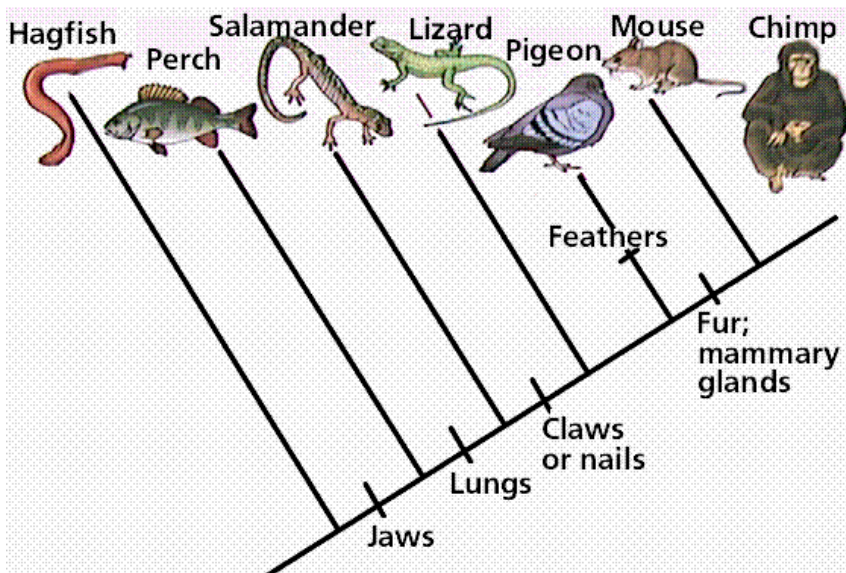
What is an advanced feature?

As animals evolve, they develop new features or characteristics. The descendants often diversify and form other groups, but they all inherit the advanced features. An advanced feature can be any attribute of an animal, from the shape of its bones and muscles to its genetic chemistry and DNA. The term “advanced” is relative – it does not necessarily mean that the feature is better or more efficient than the primitive feature that it evolved from.

Why use cladistics?

Although cladistics provides us with the best current method of determining evolutionary relationships, it is not perfect. Contradictions among advanced features often suggest alternative evolutionary trees. In such cases, the cladogram consistent with the most features is chosen for the time being. True evolutionary relationships can never be definitively established, either by examining fossils or studying DNA. But we can get closer and closer to the actual sequence of evolution by testing hypotheses about relationships with as many features as possible.





http://www.cartage.org.lb/en/themes/Sciences/Zoology/Biologicaldiversity/Classification/cladogram_1.gif

Define the following (write the answers in your notebook if you need more space):

1. Phylogeny
2. Cladogram
3. Taxonomy

Answer the following questions based on the cladogram above.

4. What characteristic distinguishes a lizard from a pigeon?
5. What does a salamander have that a hagfish does not have?
6. Which organisms have fur?

Refer to the plant cladogram on page 554 of the textbook.

7. If you found a plant with vascular tissue and seeds, what kinds of plant could it be?
8. What kind of plant would it be if it also had flowers?
9. What is the common ancestor of all plants?
10. Construct the cladogram in the Quick Lab on page 453 of the textbook in the space below. After you have completed the cladogram, answer Analysis and Conclusion question #4 (inferring).